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(54) **Plate heat exchanger**

(57) A plate heat exchanger suitable for use with a high pressure fluid is of laminated construction, with headers (24-27) defined by aligned apertures in all the plates (20), the plates each having grooves (22, 23) on one surface to provide channels between the headers. The plates are joined together by diffusion bonding.

Fig. 2.

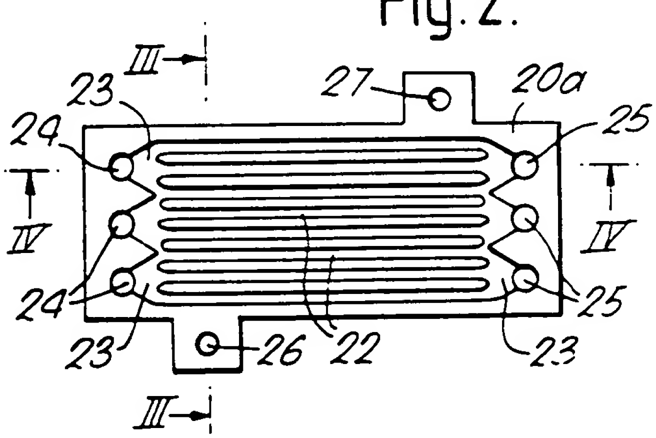

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Fig.1.

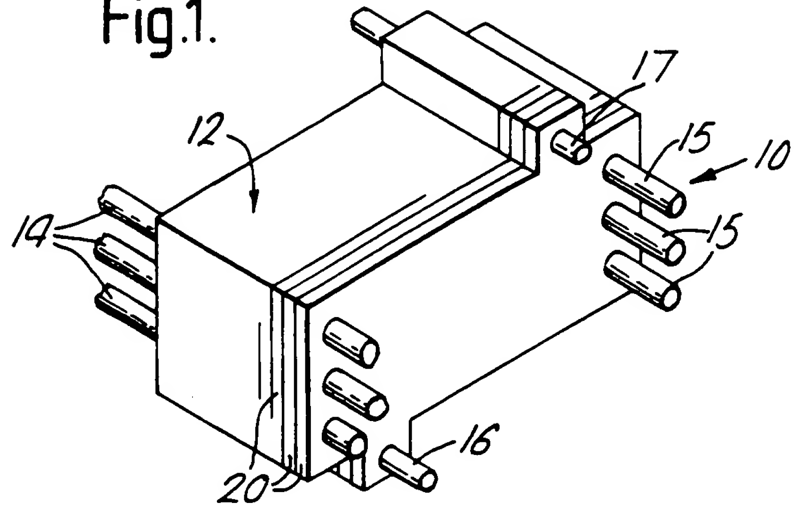


Fig.2.

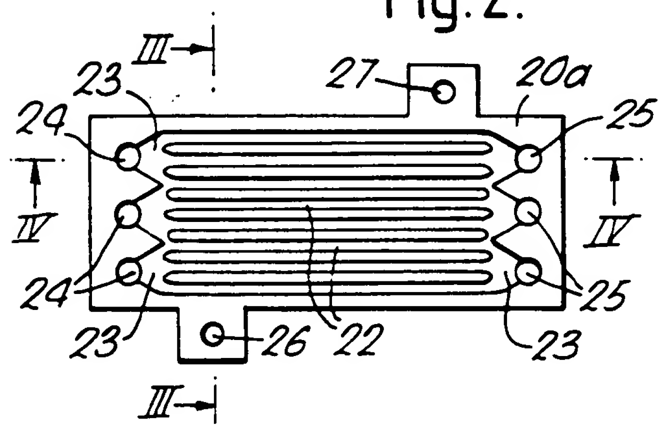


Fig.3.

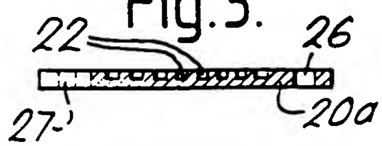


Fig.4.

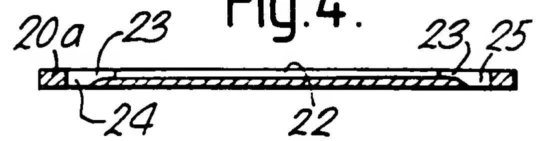
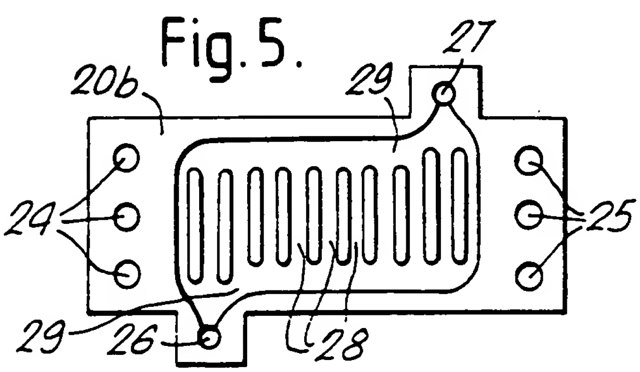


Fig.5.



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Heat Exchanger

This invention relates to a heat exchanger and to a method for making a heat exchanger, particularly but not exclusively a heat exchanger for a high pressure fluid.

According to the present invention there is provided a heat exchanger for heat exchange between two fluids of laminated construction with integral headers for the two fluids.

Preferably the heat exchanger comprises a plurality of plates, each plate defining holes or apertures there-through, and also defining grooves or recesses in at least one face thereof to provide flow channels for one or other of the fluids between two of the said holes or apertures, the plates being metallurgically bonded into a laminated structure such that the holes or apertures in different plates together define headers for the two fluids.

Preferably the plates are of titanium, and are bonded together by diffusion bonding, but they might be of another material such as stainless steel, and might be brazed together.

By incorporating the headers into the laminated structure it is possible to make heat exchangers which can withstand very high pressures. Such heat exchangers can also be made very compact.

The invention will now be further and more particularly described, by way of example only, and with reference to the accompanying drawings in which:

Figure 1 shows a perspective view of a heat exchanger;

Figure 2 shows a plan view of one plate of the heat exchanger of Figure 1;

Figure 3 shows a sectional view along the line III-III of Figure 2;

Figure 4 shows a sectional view along the line IV-IV of Figure 2; and

Figure 5 shows a plan view of another plate of the heat exchanger of Figure 1.

Referring to Figure 1, a heat exchanger 10 for heat exchange between water and a high pressure gas comprises a laminated heat exchange unit 12 through which extend eight tubes - three inlet tubes 14 for the high pressure gas, three outlet tubes 15 for the gas, an inlet tube 16 for the water, and an outlet tube 17 for the water - each of which extends right through the unit 12 and is open at each end, and each of which has a broad slot along one side of the portion within the unit 12. The fluids flow into both ends of each tube 14 and 16 and through the slots into channels within the unit 12 (to be described below); similarly the fluids leave the channels through the slots to emerge from both ends of the tubes 15 and 17. The unit 12 is formed of a large number of plates 20, each tube 14-17 locating in a tubular header chamber defined by aligned apertures 24-27 through each plate 20 (only five plates are indicated in Figure 1).

Each plate 20 is of the same generally rectangular shape with two staggered square projections on two opposite sides, and with the aforementioned apertures 24-27, as shown in Figures 2 and 5. The outermost plates 20 of the unit 12 have no surface grooves. The remaining plates 20 are of two types arranged alternately, plates 20a as shown in Figure 2, and plates 20b as shown in Figure 5.

Referring to Figures 2 to 4, the plates 20a are provided on one surface with a large number of parallel grooves or channels 22 extending parallel to the longer sides of the rectangle and of uniform depth (only eight of which are shown). The grooves 22 communicate at their ends with the apertures 24 and 25 via curved header grooves 23 of increasing depth and of greater width than the grooves 22. Referring to Figure 5, the plates 20b are provided on one surface with a large number of parallel grooves or channels 28 extending parallel to the shorter sides of the rectangle (only eleven are shown). These grooves 28 communicate at their ends with the apertures 26 and 27 via wider, curved, header grooves 29 increasing in depth towards the apertures 26 and 27.

The plates 20 are assembled to form the unit 12, the tubes 14-17 are inserted through the corresponding apertures 24-27 and arranged so the slots face the respective header grooves 23 or 29. The plates 20 and the tubes 14-17 are then metallurgically bonded together, preferably by diffusion bonding, by heating them to a high temperature while pressing the plates 20 together.

In use of the heat exchanger 10 the grooves 22 and 23 provide channels for the high pressure gas flow between the tubes 14 and the tubes 15, the aligned apertures 24 and 25 thus acting as headers for the gas. Equally the grooves 28 and 29 provide channels for the water flow between the tubes 16 and 17, the aligned apertures 26 and 27 thus acting as headers for the water, and the water flow is therefore cross-flow relative to the gas flow.

It will be appreciated that the heat exchanger might differ in many respects from that described, while remaining within the scope of the invention. For example the tubes 14-17 might be omitted, as they are not essential for operation of the heat exchanger, but merely provide

convenient means for supplying fluids to it. It will also be appreciated that the number and disposition of the apertures and grooves might differ from that described. For example the plates 20a shown in Figure 2 might be modified by the provision of grooves (not shown) directly linking adjacent apertures 24 or 25; in this case a slotted tube 14 or 15 might be provided only in the middle aperture 24 or 25 and the outer apertures 24 or 25 be blocked off by a suitable outermost plate. Where countercurrent flow is desired, all the plates might be rectangular with three holes at each end, one type of plate having grooves parallel to the longer sides linking the outer pair of holes at one end to the outer pair at the other end, and another type of plate having grooves parallel to the longer sides linking the middle hole at one end to the middle hole at the other end. These two types of plate could then be arranged alternately; the aligned outer pairs of holes would define headers for one fluid and the aligned middle holes would define headers for the other fluid. It will also be appreciated that although the two types of plate were described as being arranged alternately, they might be arranged in a different manner for example with two of one type of plate alternating with one of the other type.

This method of constructing heat exchangers with laminated integral headers makes it possible to carry out heat exchange with fluids at least one of which is at very high pressure, as the walls of the headers can readily be made of any necessary thickness, and stress concentrations due to longitudinal welds are avoided.

Claims

1. A heat exchanger for heat exchange between two fluids, of laminated construction with integral headers for the two fluids.

2. A heat exchanger as claimed in Claim 1 comprising a plurality of plates, each plate defining holes or apertures therethrough and also defining grooves or recesses in at least one face thereof to provide flow channels for one or other of the fluids between two of the said holes or apertures, the plates being assembled so the holes or apertures in different plates together define headers for the two fluids.

3. A heat exchanger as claimed in Claim 2 comprising titanium plates.

4. A heat exchanger as claimed in Claim 2 comprising stainless steel plates.

5. A heat exchanger as claimed in Claim 2, 3 or 4 wherein the plates are bonded metallurgically into a laminated structure such that the holes or apertures in different plates together define headers for the two fluids.

6. A heat exchanger as claimed in Claim 5 wherein the plates are bonded together by diffusion bonding.

7. A method of making a heat exchanger for heat exchange between two fluids comprising forming a plurality of plates, each plate defining holes or apertures therethrough and also defining grooves or recesses in at least one face thereof to provide flow channels for one or other of the fluids between two of the said holes or apertures, and assembling the plates into a laminated structure such that

the holes or apertures in different plates together define headers for the two fluids.

8. A method as claimed in Claim 7 wherein the plates are bonded together by diffusion bonding into an integral structure.

9. A heat exchanger substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

10. A method of making a heat exchanger substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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